

## Lesson 1

# Understanding the Epidemiologic Triangle through Infectious Disease

## Section

Diseases

### Investigative Questions

What is our experience with infectious diseases and what do we know about them? What are the parts of the Epidemiologic Triangle and how does it help us understand any infectious disease?

### Relevant Standards

This activity fulfills [science and health education standards](#).

### Teacher Background

This series of lessons will introduce students to epidemiology through infectious diseases and the scientific methods epidemiologists use to investigate those diseases. Although these same methods are used to investigate other health issues (for example, chronic disease, environmental problems, behavioral problems, and injuries), these lessons focus on infectious disease to provide a clear example of epidemiology that is appropriate for students at the middle school level. For more information on the broad applications of epidemiology, see the [“What is Epidemiology?”](#) and [“Why Teach Epidemiology?”](#).

### *Infectious Disease*

Infectious diseases are diseases caused by microbes and that spread. The reason for most sick days for both kids and teachers is an infectious disease. There are many, from the common cold, ear infections, tonsillitis, and the flu (influenza) to pneumonia and mononucleosis.

Infectious diseases are caused by microbes—organisms too small to be visible to the naked eye. The most common infectious disease-causing microbes are bacteria, viruses, fungi, and protozoa (a type of parasite).

The diseases may be passed from person to person (for example, if someone coughs or sneezes on another person). Sometimes, the disease is passed through another medium, for example, by drinking water or eating food infected with bacteria.

Some diseases, such as Lyme disease, are passed from an animal carrier (including insects and worms) to humans. Deer ticks pick up Lyme disease from small animals such as mice (who don’t even get sick from the disease), lay their eggs and travel around on deer, and sometimes end up on humans who can get sick if bitten. (Ticks, fleas, mosquitoes, flies, and cockroaches all can carry disease so it is best to protect your body, food, water, and homes from them.)

Sometimes, infectious diseases develop new strains that resist older treatments. During the 1980s, tuberculosis (TB)—a disease that had nearly been eliminated in developed

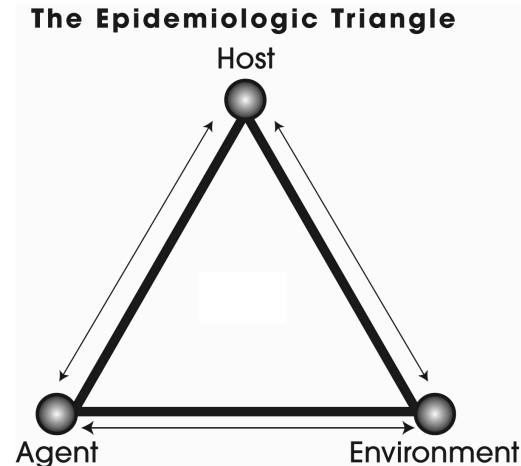
countries through successful treatments with antibiotics—reemerged. In some cases, the new strain of TB was drug-resistant (antibiotics that worked before now did not work).

### *The Epidemiologic Triangle*

The Epidemiologic Triangle is a model that scientists have developed for studying health problems. It can help your students understand infectious diseases and how they spread. It also gives students a chance to apply a scientific model to a variety of circumstances and facts.

The Triangle has three corners (called *vertices*):

- *Agent*, or microbe that causes the disease (the “what” of the Triangle)
- *Host*, or organism harboring the disease (the “who” of the Triangle)
- *Environment*, or those external factors that cause or allow disease transmission (the “where” of the Triangle)



An *outbreak* or an *epidemic* exists when there are more cases of a particular disease than expected in a given area, or among a specific group of people, over a particular period of time. Another other term you might come across is *endemic*, when a population has a high level of the disease all the time. For example, giardiasis and even malaria are endemic in parts of the world.

**The mission of an epidemiologist is to break at least one of the sides of the Triangle, disrupting the connection between the environment, the host, and the agent, and stopping the continuation of disease.** For examples of epidemiologists at work, see the *BAM!* site at [www.bam.gov/sub\\_diseases/diseases\\_detectives.html](http://www.bam.gov/sub_diseases/diseases_detectives.html), [www.bam.gov/sub\\_diseases/diseases\\_sars\\_who.html](http://www.bam.gov/sub_diseases/diseases_sars_who.html), [www.bam.gov/sub\\_diseases/diseases\\_wnv.html](http://www.bam.gov/sub_diseases/diseases_wnv.html), and [www.bam.gov/sub\\_yourbody/yourbody\\_smoking.html](http://www.bam.gov/sub_yourbody/yourbody_smoking.html).

Here are more details on the parts of the Epidemiologic Triangle:

Vertex 1.

#### **The Agent—“What”**

The agent is the cause of the disease. When studying the epidemiology of most infectious diseases, the agent is a microbe—an organism too small to be seen with the naked eye. Disease-causing microbes are bacteria, virus, fungi, and protozoa (a type of parasite). They are what most people call “germs.”

**Bacteria:** Bacteria are single-celled organisms. Bacteria have the tools to reproduce themselves, by themselves. They are larger than viruses (but still much too small to be seen with the naked eye). They are filled with fluid and may have threadlike structures to move themselves, like a tail.

**Virus:** A virus may have a spiny outside layer, called the envelope. Viruses have a core of genetic material, but no way to reproduce it on their own. Viruses infect cells and take over their reproductive machinery to reproduce.

**Fungi:** Fungi are like plants made up of many cells. They are not called plants because they cannot produce their own food from soil and water. Instead, they live off animals, including people, and plants. Mushrooms and yeast are fungi.

**Protozoa:** Protozoa are very small. Most live in water. They are parasites, which means they live off other organisms, in some cases humans. Malaria is a parasitic protozoan, as is *Giardia*.

Vertex 2.

### **The Host—“Who”**

Hosts are organisms, usually humans or animals, which are exposed to and harbor a disease. The host can be the organism that gets sick, as well as any animal carrier (including insects and worms) that may or may not get sick. Although the host may or may not know it has the disease or have any outward signs of illness, the disease does take lodging from the host. The “host” heading also includes symptoms of the disease. Different people may have different reactions to the same agent. For example, adults infected with the virus *varicella* (chickenpox) are more likely than children to develop serious complications.

Vertex 3.

### **The Environment—“Where”**

The environment is the favorable surroundings and conditions *external* to the host that cause or allow the disease to be transmitted. Some diseases live best in dirty water. Others survive in human blood. Still others, like *E. coli*, thrive in warm temperatures but are killed by high heat. Other environment factors include the season of the year (in the U.S., the peak of the flu season is between November and March, for example).

### **Time**

In the center of the Triangle is time. Most infectious diseases have an incubation period—the time between when the host is infected and when disease symptoms occur. Or, time may describe the duration of the illness or the amount of time a person can be sick before death or recovery occurs. Time also describes the period from an infection to the threshold of an epidemic for a population. *These lessons do not specifically cover the time because it is a complex concept for middle school students; however, it can be covered as an extension for advanced students.*

Warm-up

## **What's our experience with infectious disease?** (50 minutes)

### **Description of Content**

This activity will get students interested in infectious diseases by discussing and charting their own experiences. Students will, without knowing it, act like young epidemiologists.

### **Objectives**

Students will:

- Describe what infectious diseases are and how they spread
- Explore their own family's experience with infectious diseases

### **Materials**

- Student Reproducible 1: *Infectious Diseases*

### **Safety**

Normal classroom safety guidelines should be observed.

### **Procedure**

*Engagement* (30 minutes over two days)

1. Give students Student Reproducible 1: *Infectious Diseases*. Tell them to take this list home and discuss with their families what diseases they have had, their parents have had, and their grandparents may have had, and mark these on the list. Make sure to tell students that they don't have to mark anything they or their family might be uncomfortable sharing.
2. The next day in class, write the word "Epidemiology" on the board. Explain to students that it is scientific method of problem solving that "disease detectives" use to get to the root of health problems.
3. Tell students that they will be studying "infectious" diseases, those that are usually caused by microbes ("germs") and that spread.

#### **Did you know?**

The word *epidemiology* comes from three Greek root words:

*Epi*—means "on, upon, befall" (think of *epidermis*—"upon the body")

*Demo*—means "people" (think of *demographics*—"the study of statistics of populations")

*-ology*—means "the study of"

So *Epidemiology* is literally defined as "the study of that which befalls people."

4. Put students in groups of two or three. Have each group divide a piece of paper into three columns:

Infectious Diseases I've Had	Infectious Diseases My Parents or Grandparents Had, but I Never Did	Infectious Diseases I've Heard About

5. Give students 5 to 10 minutes to fill in the chart.
6. Now ask groups to report on what's in their charts. Write the answers on the board. When more than one group names the same disease, put a check mark next to it. Do this quickly. When students list diseases or medical conditions that are not infectious (cancer, broken leg), explain briefly why they do not fit. If you are not sure whether the disease is infectious or not, create a list labeled with a question mark. Students can research these diseases later.

Your board might look like this:

Infectious Diseases I've Had	Infectious Diseases My Parents or Grandparents Had, But I Never Did	Infectious Diseases I've Heard About
Colds (15 checks)	Measles	AIDS
Ear infections (10 checks)	Polio	Malaria
Chickenpox (5 checks)	Scarlet fever	Cholera
Tonsillitis (3 checks)	Rocky Mountain spotted fever	
Flu (8 checks)	Giardia	

7. Ask students what conclusions they can draw from this list. Answers may include:

- Certain infectious diseases are very common.
  - There are some diseases our parents or grandparents had but we don't get any more.
  - There are other infectious diseases we've heard of but not experienced.
8. Point out to students that they have just done a simple epidemiological study—learning how diseases are distributed in place and time. They have seen which diseases are most common among kids their age, which diseases their parents or grandparents might have had but that people their age usually do not (mostly because of vaccinations), and serious diseases they know people around the world may get, but we usually do not. If this activity had been done by a class in a poorer region of world, the findings would have been very different.

*Exploration (20 minutes)*

1. Ask why our parents and grandparents had diseases we did not. One reason is vaccination. Students can explore the *Immune Platoon* on the *BAM!* Web site at [www.bam.gov/sub\\_diseases/diseases\\_immuneplatoon.html](http://www.bam.gov/sub_diseases/diseases_immuneplatoon.html) for more information on vaccination and share it with the class.
2. Ask students to find out more about infectious diseases that are prevalent in the developing world and report on these to the class. Have them research factors (e.g., sanitation or lack of vaccines, food, water, or shelter) that allow the diseases to flourish. Students might also learn more about CDC epidemiologists who act as “disease detectives.” (For examples, visit [http://www.bam.gov/sub\\_diseases/diseases\\_detectives.html](http://www.bam.gov/sub_diseases/diseases_detectives.html), [http://www.bam.gov/sub\\_diseases/diseases\\_sars\\_who.html](http://www.bam.gov/sub_diseases/diseases_sars_who.html), [www.bam.gov/sub\\_diseases/diseases\\_wnv.html](http://www.bam.gov/sub_diseases/diseases_wnv.html), and [www.bam.gov/sub\\_yourbody/yourbody\\_smoking.html](http://www.bam.gov/sub_yourbody/yourbody_smoking.html).)

## Working the Epidemiologic Triangle (1 hour)

### Description of Content

This activity will help you teach about the scientific concept of the Epidemiologic Triangle using an infectious disease example. Once students understand the Triangle, they can apply it to other diseases they study. This exercise will refine research, reasoning, and problem solving skills.

You will present the Epidemiologic Triangle to students and show them how it helps organize information about a specific disease. This is the same technique that epidemiologists use when they are researching the outbreak of a disease.

You will use the example of *Escherichia coli* (*E. coli*) in describing the three vertices (corners) of the Epidemiologic Triangle. Those vertices are “agent,” “host,” and “environment.” After this in-class introduction, students will gather information about chickenpox and report back to the class on what they have learned.

### Objectives

Students will:

- Describe the interaction and interdependence of agent host, and environment—the Epidemiologic Triangle
- Apply this concept to other diseases
- Describe how epidemiologists think about the causes and spread of an infectious disease

### Materials

- Student Reproducible 2: *The Epidemiologic Triangle*

### Safety

Normal classroom safety guidelines should be observed.

### Procedure

*Explanation* (15 minutes)

1. Tell your students they are now going to learn how epidemiologists or “disease detectives” study an infectious disease. They use a method called *The Epidemiologic Triangle*.
2. Hand out the Student Reproducible 2, *The Epidemiologic Triangle*. Draw a large triangle on the board.
3. Ask a student to read the definition of “agent” written on his or her handout. This is the “what” of the Triangle. Ask the class if they know the agent for any of the

diseases they discussed earlier. (Most of them will not.) Tell them that the information is available to doctors and scientists, and also may be available on the Internet. They will be doing some research into agents at a later time.

As an example, you might want to talk briefly about an agent they might be familiar with, *E. coli*. Some forms of the bacteria *E. coli* cause food poisoning. (You may have a news story about an example of people who got sick from eating food that was infected with *E. coli*.) *E. coli* bacteria can be found in the intestines and waste of animals and people. The bacteria are transmitted through food, water, or anything else contaminated with feces. When meat containing the *E. coli* bacteria is consumed uncooked or undercooked, it can make you sick. Cold temperatures, for example in the refrigerator, can keep *E. coli* from multiplying quickly. Warm temperatures—for example, room temperature or being out in the sun—make the bacteria multiply quickly. High heat kills the bacteria. That’s why meat needs to be cooked thoroughly and hot foods need to be refrigerated immediately after a meal. (For more information on food safety, visit the *BAM!* Web site article, *Power Packing*, at [www.bam.gov/sub\\_foodnutrition/powerpacking.html](http://www.bam.gov/sub_foodnutrition/powerpacking.html).)

4. Ask a student to read the definition of “host.” This is the “who” of the Triangle. Under this heading, students can also describe the symptoms of the disease a “host” may experience. For *E. coli*, they include nausea, diarrhea, and vomiting. Among older people or babies whose bodies are not as strong, or people with another illness, it may cause death.
5. Ask a student to read the definition of “environment.” This is the “where” of the Triangle. You can again use *E. coli* as an example. The bacteria are found in the digestive tract of animals and people, and are spread through their feces. When livestock is slaughtered, it is possible for meat to become contaminated with *E. coli* if it comes in contact with the animal's infected feces. That infected meat then has the chance to make you sick if it is under- or improperly cooked. *E. coli* can be killed by thorough cooking, which is one reason meat should never be eaten raw or rare. *E. coli* can live in water and can infect fruit and vegetables irrigated by that water. Usually water used to irrigate is tested to be sure it does not contain *E. coli* or other dangerous bacteria and produce found in the grocery store is washed before it is packed. (It is still a good idea to wash fruits and vegetable before eating them.)
6. Explain that the mission of an epidemiologist is to break at least one of the sides of the Triangle, disrupting the connection between the environment, the host, and the agent, and stopping the continuation of disease.
7. Explain that for some diseases, there are vaccines. Ask students to list some of the diseases they have been vaccinated against (measles, mumps, rubella, diphtheria, tetanus, and pertussis or “whooping cough”). There is no vaccine for *E. coli*.



*Elaboration* (30 minutes)

1. This activity may be done in class, or it may also be given as a homework or computer lab assignment. Divide students into groups. Give each group a copy of Student Reproducible 2, *The Epidemiologic Triangle*.
2. Tell students they are going to become epidemiologists, looking at a common childhood disease—chickenpox—in a careful and organized way. Using the information available in the *BAM!* Web site *Immune Platoon* section at [www.bam.gov/sub\\_diseases/diseases\\_immuneplatoon.html](http://www.bam.gov/sub_diseases/diseases_immuneplatoon.html), have students research and describe the agent, the host (including symptoms of the disease), and environment.
3. If you have a more advanced group of students you may want to divide them into groups of two or three students and have the groups explore different diseases. The content they need for hepatitis B, influenza, and meningitis is on the *BAM!* Web site at [www.bam.gov](http://www.bam.gov). The discussion after would be to compare and contrast the diseases.
4. When students have completed the activity, review the answers in class. Clearly point out to students that any disease can be understood by looking at the agent, the host, and the environment.

*Evaluation* (15 minutes)

Ask students the following questions:

1. Can you describe in your own words the Epidemiologic Triangle and how it works?
2. Why is the Triangle important to understanding the spread of infectious diseases and how to stop them?
3. What are the agent, host, and environment for chickenpox and other diseases you looked at?
4. What have you learned about epidemiology and how epidemiologists work?

## Performance Descriptors

<b>Student Reproducible 2: <i>The Epidemiologic Triangle</i></b>	
<b>Rating</b>	<b>Performance Descriptor</b>
<b>4</b>	Worksheet clearly shows all three vertices of the Epidemiologic Triangle: agent, host, environment. Information is correct.  Students clearly and accurately describe the interaction and interdependence of all of the vertices of the Epidemiologic Triangle.
<b>3</b>	Worksheet shows three vertices of the Epidemiologic Triangle: agent, host, environment. However, information may be incomplete for one or more vertices.  Students describe the interaction and interdependence of most of the vertices of the Epidemiologic Triangle.
<b>2</b>	Worksheet shows information on at least two of the vertices of the Epidemiologic Triangle. Information may be incomplete for one of the vertices listed.  Students describe the interaction and interdependence of two of the vertices of the Epidemiologic Triangle.
<b>1</b>	Worksheet shows only one vertex of the Epidemiologic Triangle.

## Web Resources

CDC *BAM! Body and Mind*<sup>TM</sup>: [www.cdc.gov/bam](http://www.cdc.gov/bam) or [www.bam.gov](http://www.bam.gov)

*BAM! Body and Mind* is brought to you by the Centers for Disease Control and Prevention (CDC), an agency of the U.S. Department of Health and Human Services (DHHS). *BAM!* was created to answer kids' questions on health issues and recommend ways to make their bodies and minds healthier, stronger, and safer. *BAM!* also serves as an aid to teachers, providing them with interactive activities to support their health and science curriculums that are educational and fun.

Centers for Disease Control and Prevention (CDC): [www.cdc.gov](http://www.cdc.gov)

The CDC Web site provides a comprehensive overview of the latest research on infectious diseases. From research studies on infectious diseases to information for travelers, this site provides a wealth of information. Some is written for medical professionals, but much of the information is written for health care consumers. The section on chickenpox

([www.cdc.gov/ncidod/diseases/list\\_varicl.htm](http://www.cdc.gov/ncidod/diseases/list_varicl.htm)) may be particularly useful as students complete this activity.

### **Text Correlations**

Glencoe, *Teen Health, Level 1*, Chapter 12: Understanding Communicable Diseases

Glencoe, *Teen Health, Level 2*, Chapter 7: Preventing Diseases

Glencoe, *Teen Health, Level 3*, Chapter 11: Medicines and Drugs

Glencoe, *Teen Health, Level 3*, Chapter 17: Communicable Diseases

### **Relevant Standards**

#### *Benchmarks for Science Literacy*

By the end of the 8th grade, students should know that:

#### Chapter 6, Benchmark E, Grades 6-8: Physical Health

- Viruses, bacteria, fungi, and parasites may infect the human body and interfere with normal body functions. A person can catch a cold many times because there are many varieties of cold viruses that cause similar symptoms.

#### *National Health Education Standards*

##### Standard 1

Students will comprehend concepts related to health promotion and disease prevention.

- Explain the relationship between positive health behaviors and the prevention of injury, illness, disease and premature death.
- Analyze how environment and personal health are interrelated.
- Describe how lifestyle, pathogens, family history and other risk factors are related to the cause or prevention of disease and other health problems.

Lesson 1, Activity 1, Student Reproducible 1:

**Infectious Diseases**

Please discuss what diseases your family has experienced (What have you had? What have your parents had? What may your grandparents have had?) and mark these on the list below. You do not have to mark anything that you or your family might be uncomfortable sharing.

**Note to parents:** There are probably infectious diseases you or your parents had—for example, mumps—that kids today don't get. The purpose of this exercise is to show students some of the ways in which we have made progress in fighting the kinds of infectious diseases that used to be so common among children. Thank you for participating.

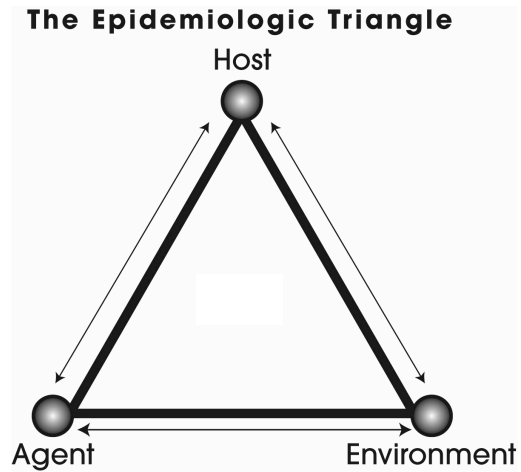
[Insert exhaustive list of infectious diseases from CDC]

### ***The Epidemiologic Triangle***

**Vertex 1. The Agent—“What”**

The agent is the cause of the disease. The agent is usually a microbe, an organism too small to be seen with the naked eye. Most people call an agent a “germ.”

*My research on the “agent” for chickenpox shows that it is:*



**Vertex 2. The Host—“Who”**

Hosts are organisms, usually humans or animals, which have been exposed to and harbor a disease. The host can be the organism that gets sick, as well as any animal carrier (including insects and worms) that may or may not get sick. The same microbe affects different hosts in different ways.

*My research on the “host” for chickenpox (including symptoms of the disease) shows:*

**Vertex 3. The Environment—“Where”**

The environment is the favorable surroundings and conditions *outside* the host that cause or allow the disease to be transmitted. Some diseases live best in dirty water. Others can survive only in blood. Many infectious disease microbes live in the mucus in your nose and mouth.

*My research on the “environment” for chickenpox shows:*

Is there a vaccine for chickenpox? Describe it and its level of success in preventing the disease. Which side of the Epidemiological Triangle does it break?:

## **Answers to Student Reproducible 2, *The Epidemiologic Triangle*:**

### **Agent**

*Varicella zoster*, a virus.

### **Host**

Most people who get the disease are under age 15, but anyone who has not had the disease is susceptible. A person usually only has one episode of chickenpox in a lifetime.

Symptoms are itchy rash (blisters) and fever, but there can be serious complications from the disease. In 23 of every 10,000 cases, pneumonia can develop. Encephalitis (swelling of the brain) occurs in 1 out of every 10,000 cases of chickenpox.

It can remain in the body, reemerge, and cause shingles (painful blisters) in people (mostly adults) who previously had chickenpox, even years later.

### **Environment**

It is transmitted from an infected person through coughs or sneezes and from contact with the fluid in the chickenpox blisters. It is very contagious. Once a case has occurred in a group—such as a classroom—it is very hard to prevent an outbreak unless people are immunized. In North America, chickenpox outbreaks are most common at the end of winter and the start of spring, periods of moderate temperature when viruses thrive.

This CDC Web site has more background information on chickenpox for you or for advanced students: [www.cdc.gov/ncidod/diseases/list\\_varicel.htm](http://www.cdc.gov/ncidod/diseases/list_varicel.htm).

Information on many diseases and public health issues is listed alphabetically at this CDC Web site: [www.cdc.gov/az.do](http://www.cdc.gov/az.do).